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October 1, 1984
ASD-84-632

Mr. Al Cimorelli
U.S. Environmental Protection Agency
Region III
6th and Walnut Streets
Philadelphia, PA 19106

SUBJECT: Meteorological and Air Quality Assessment for the Lackawanna Refuse Site

Dear Al,

Based on our prior conversations NUS has performed an assessment for applying data collected during the December 1983 field program for meteorological support for the upcoming test pit excavation at Lackawanna. The idea was to develop a methodology for making near-realtime assessments of relative air concentrations (CHI/Q) and dispersion factors (i.e. the relative decrease in concentration downwind) using available onsite meteorological data.

Attachment I presents the result of NUS' evaluation of your suggestion of adjusting sigma theta categories according to roughness length by examining wind profiles developed from tethersonde flight data that were taken in the vicinity of Pit No. 5. The adjusted categories would then be used to determine a representative stability class using onsite measured sigma theta values for estimating near-realtime atmospheric dispersion factors and CHI/Q values in support of the planned test pit excavation. However, examination of the results presented in Attachment 1 indicates that this methodology does not appear to provide a technically acceptable solution to realistically estimate CHI/Q values or dispersion factors. Because of this, an alternate approach was then developed.

Hank Firstenberg with some input and discussion from Bob Jubach and myself developed a methodology that will realistically estimate CHI/Q values using wind measurements from the onsite 10m tower. This methodology is based on detailed analysis of the maximum concentration and wind data collected during the previous SF_6 tracer tests. A detailed description is presented in Attachment 2.

The dispersion modeling approach presented in Attachment 2 is an extension of the analysis previously applied by NUS to the Celanese air quality monitoring data, with which you are familiar.

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As a result of our evaluation, NUS believes that using the results of the analyses of the tracer test data with the dispersion modeling approach presented in Attachment 2 will provide a realistic estimation of CHI/Q values and dispersion factors required to support the test pit excavation. This methodology will more realistically apply the results of the tracer test as compared to the previous application during the initial excavation in April 1984. Additionally, this modeling technique may also possibly be applicable to the air quality input assessments required for the feasibility study (FS). However, the FS will require a more complex evaluation and further development of the model because of the treatment required to evaluate multiple sources and to assess off-centerline concentrations. It appears at this time that current schedule and budget constraints will likely not allow this approach to be applied for all FS modeling scenarios.

Please review and comment on the information depicted in Attachments 1 and 2 and the proposed applications to the test pit excavation with consideration of additional application to the feasibility study. With the excavation tentatively scheduled for the week of October 29, I would appreciate your comments as soon as possible since some preparation is needed to provide calculational tables, charts, etc. for use in the onsite command post.

Please contact me, Hank Firstenberg, or, during our absences, Bob Jubach if you have any questions.

Sincerely,

RJubach

for Thomas Iaccarino
Senior Environmental Meteorologist

cc: ~~W.~~ Graham (EPA)
R. Ninesteel (NUS)
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ATTACHMENT 1

Adjusting Sigma Theta Categories by Surface Roughness Length (Z_O)

NUS investigated the possibility of adjusting existing, standard sigma theta categories by surface roughness length (Z_O) using wind profiles developed from tethersonde flight data that were taken in the vicinity of Pit No. 5 during the December 1983 tracer test.

Specifically, the following activities were performed:

1. Tethersonde wind speed data taken from three flights in December 1983 in the vicinity of Pit No. 5 were processed and used to develop wind profiles.

2. These site-specific profiles were evaluated against a theoretical profile (Rao, 1974) which assumed a Z_O of 15 cm.

An analysis was performed using the site data and a logarithmic wind power relationship to estimate the friction velocity and the roughness height. The approach used was to obtain a regression equation for the site data and determine the friction velocity and roughness height from the slope and intercept of the regression: $u(z) = m \ln z + b$. Correlation coefficients calculated from the regression analyses were all approximately 0.5. Calculations of Z_O were then performed on each set of site data and resulted in values of Z_O ranging between 0.3 to 0.6 cm. However, expected Z_O values based upon the Högström (1978) classification for Z_O values for typical terrain types are on the order of 80 cm (forest) to 120 cm (very hilly).

Therefore, it is NUS' opinion that tethersonde flight data collected during the study cannot be adequately used to estimate realistic Z_O values. This may potentially be attributable to short term (near instantanous) wind speed measurements being taken at an approximate 4 meter/minute ascent rate by the tethersonde. To adequately characterize the wind speed profiles, longer averaging times are likely required. Additionally, the primary purpose and application of the tethersonde was to synoptically characterize the meteorology in the vertical with emphasis for the temperature profile in order to estimate the vertical stability class.

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REFERENCES

1. Högström, A-S and U. Högström, "A Practical Method for Determining Wind Frequency Distributions for the Lowest 200m from Routine Meteorological Data", JAM, Vol 17, July 1978; p. 953.

2. Rao, K.S., J.C. Wyngaard and O.R. Coto, 1974, "The Structure of the Two-Dimensional Internal Boundary Layer Over a Sudden Change of Surface Roughness". JAS, Vol 31, pp 738-746.

ATTACHMENT 2

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C-582-10-4-18

OCTOBER 1, 1984

AN ANALYSIS OF THE LACKAWANNA REFUSE SITE TRACER EXPERIMENTS FOR APPLICATION TO AN EXPLORATORY EXCAVATION EMERGENCY RESPONSE PLAN

1.0 BACKGROUND

During December 1983, NUS conducted a series of SF_6 tracer field tests in an effort to characterize the site-specific atmospheric dispersion in the complex terrain of the Lackawanna Refuse Site in Old Forge, Pennsylvania. The results of these tracer experiments were summarized in NUS-4472.[1] While these data clearly indicated an enhanced dispersion of the SF_6 tracer by the complex terrain between the release site and the samplers, the efforts to correlate these data did not meet with very much success. This memorandum re-examines these data by a somewhat different approach, with the primary objective of their application in an emergency response plan for the exploratory excavations scheduled late in October.

Two criteria were established for this particular application of the analysis. First, the meteorological data available for emergency response decisionmaking would consist of the horizontal wind speed, wind direction, and wind direction variance from a 10-meter tower located near Pit No. 5. Second, the potential offsite risk to the public from onsite activities must be capable of timely assessment and provide evacuation information to the agencies responsible for emergency response decisionmaking. These criteria can be satisfied by the application of the SF_6 tracer data to predict the maximum concentration as a function downwind distance and an angular sector within which unacceptable levels of concentration may be experienced by the public.

2.0 CONCLUSIONS AND RECOMMENDATIONS

An analysis of the tracer field experiments presented in NUS-4472[1] was performed, using a model based on the treatment of plume meander presented in an earlier NUS document.[2] This model was applied to the tracer test data to assess whether or not it would be possible to predict the maximum concentration and the evacuation sector for the purpose of emergency response decisionmaking during the exploratory excavations planned at the Lackawanna Refuse Site. As a criterion, the model had to use information available from the 10-meter meteorological tower to provide reliable and timely predictions of the maximum concentration and the evacuation sector in the event of an accident airborne release of a hazardous or toxic substance.

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When the model was applied to the tracer test data, it was found that the observed maximum concentrations for tracer tests with winds from the southwest could be represented by

$$\frac{\overline{X}_0(R)}{Q} = \frac{0.3989}{\sigma_z R |\Theta_m| \overline{u}} \; \frac{\text{second}}{(\text{meter})^3}$$

where

R = downwind distance: meters
$|\Theta_m|$ = $0.03023\sigma_\Theta$: radians
σ_Θ = horizontal wind direction standard deviation: degrees
$\overline{u}$ = mean wind speed: meters/second

and

$$\sigma_z = [9.184\sigma_\Theta - 87.33]\left(\frac{R}{940}\right)^{0.75}$$

This relationship applies to field tests with the following range of parameters

$$228^\circ \leq \overline{\Theta} \leq 255^\circ$$
$$11.3^\circ \leq \sigma_\Theta \leq 20.6^\circ$$
$$1.39 \leq \overline{u} \leq 3.35 \text{ m/s}$$

There was a more limited set of data available with winds from the north. At the outer receptor ring, approximately 1100 meters from the source, the four tracer tests could be fit quite well by a constant σ_z = 63.5 meters, although the measured value of σ_Θ varied between 20.1° and 28.6°. This suggests that the dispersion is dependent on the wind direction, with plumes advecting toward the south (northerly winds) being more compact and, hence, giving larger values of the maximum concentration. The value of the vertical dispersion -parameter is similar to a Pasquill-Gifford σ_z for a C-stability. The standard deviation of the horizontal wind direction would result in a B-stability for three tests and an A-stability for the fourth test. The vertical temperature profile obtain from the tethersonde resulted in a neutrally stable atmosphere for all the tracer tests. Since the vertical dispersion parameter *did not exhibit a dependency on* σ_Θ, *it is suggested that* the maximum concentration be approximated from the above equation with:

$$\sigma_z = 63.5 \left(\frac{R}{1100}\right) \text{ meters}$$

The predictive capability of the NUS model was compared to a split-sigma and a stability-class modified bivariate, Gaussian plume model. A split-sigma model used the Pasquill-Gifford dispersion parameters, with σ_z determined from the stability class given by the tethersonde data (D-stability) and σ_v

from the stability class inferred from σ_Θ. The stability-class modified Gaussian plume model assumed the vertical and horizontal Pasquill-Gifford dispersion parameters to be determined solely from the σ_Θ data. The NUS model gave the best representation of the observed maximum concentrations while the split-sigma model was the poorest. The stability-class modified plume model predictions could be improved by imposing the empirical constraint that only C- and B- stability classifications be used; that is, a D-stability would use dispersion parameters of a C-stability and an A-stability would use dispersion parameters of a B-stability. When the NUS and modified-stability models were scaled to ensure that the ratio of the predicted-to-observed maximum concentration was never below unity, the NUS model was shown to still give better predictions than the stability-modified bivariate, Gaussian plume model. It is recommended that the NUS model be used with a scale factor of 1.78 to ensure that all predicted maximum concentrations are larger than those observed during the tracer tests; that is,

$$\frac{\overline{\chi}_o(R)}{Q} = \frac{0.710}{\sigma_z R |\Theta_m| \overline{u}}$$

This relationship will yield a maximum concentration that, on the average, is about 75 percent higher than the observed maximum concentration.

The definition of an evacuation sector can be obtained from the NUS model (see Section 4.0), which depends on the degree of reduction from the maximum concentration one desires. The angle on either side of the mean wind direction is given by

$$\mu = \sqrt{3}\,\sigma_\Theta + \sin^{-1}\left[\frac{\sqrt{2}\,\sigma_y}{R}\, C\left(\frac{\overline{\chi}}{\chi_o}\right)\right]$$

where the values of $C\left(\overline{\chi}|\chi_o\right)$ are given in Section 4.0. It is recommended that σ_y values for a B-stability be used to provide a conservative estimate of the evacuation sector.

3.0 METHOD OF ANALYSIS

The approach used to analyze and correlate the SF_6 tracer data were outlined in NUS-4060,(2) and have been further developed for the current application. The basis of this model is an interpretation of the horizontal wind direction variance as a measure of the meander experienced by a bivariate Gaussian plume. Using a theoretical probability density function, the model predicts the expected concentration at a fixed receptor downwind of a point source. The theoretical equation for the maximum concentration is of the form

$$\frac{u\,\overline{\chi}(q)}{Q} = \frac{1}{\pi\sigma_y\sigma_z}\left[\frac{\sin(|\Theta_m|)}{|\Theta_m|}\right]\left[\frac{I(q)}{q}\right] H(q, \Theta_m)$$

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where

$$q = \frac{R}{\sqrt{2}\,\sigma_y} \sin(|\Theta_m|)$$

$$I(q) = \frac{\sqrt{\pi}}{2} \operatorname{erf}(q)$$

and H(q, m) is a function bounded by

$$1.0 \leq H(q, \Theta_m) \leq \frac{|\Theta_m|}{\sin(|\Theta_m|)}$$

In these relationships R denotes the distance from the point source to the fixed receptor, and the wind direction is considered an independent random variable with a uniform probability density function:

$$f(\Theta) = \frac{1}{2\Theta_m} \quad \text{for} \quad |\Theta| < \Theta_m$$

$$= 0 \quad \text{for} \quad |\Theta| \geq \Theta_m$$

This model relates the value of Θ_m to the standard deviation of the horizontal wind direction by

$$|\Theta_m| = \sqrt{3}\,\sigma_\Theta$$

In order to test the ability of the model to interpret the SF_6 tracer data, predictions of the behavior of $\overline{u}\,\overline{X}/Q$ as a function of the standard deviation of the horizontal wind direction were made based on the standard Pasquill-Gifford dispersion parameters as a function of the atmospheric stability classification. These predictions were then compared to the maximum concentrations* from Test Nos. 7, 8, 9, 10, 11, 16, 17, and 18. These tracer experiments were characterized by a vertical temperature profile that would classify the atmosphere as neutrally stable in the vertical direction, but the measured values of σ_Θ at the 10-meter meteorological tower implied horizontal stability classifications from neutral (D-stability) to unstable (B-stability). This comparison of the predicted and measured concentrations are shown in Figure 1. The horizontal atmospheric stability classification associated with measured values of σ_Θ are indicated at the top of each curve.

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*The maximum concentrations were obtained from a curve faired through the measured concentration data. This approach was necessary since the actual maximum concentration was not measured in all the tests. The values of the maximum concentrations, as well as the measured meteorological conditions, are summarized in Table 1. The data for Test Nos. 19, 20, 21, and 22 are included in this table.

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TABLE 1

SUMMARY OF TRACER TEST RESULTS AT
LACKAWANNA REFUSE SITE

Test Number	Distance (meters)	Maximum χ/Q^{+} (sec/meters^3)	$\bar{u}^{++}$ (meters/sec)	σ_{Θ}^{++} (deg)	$\bar{\Theta}^{++}$ (deg)
7	945 1,370	3.2×10^{-5} 1.6×10^{-5}	1.39	11.3	255
8	910 1,363	2.9×10^{-6} 1.6×10^{-6}	3.35	19.3	234
9	922 1,363	2.4×10^{-6} 1.5×10^{-6}	2.73	20.6	228
10	916 1,321	3.2×10^{-6} 1.8×10^{-6}	2.77	17.8	235
11	950 1,362	6.6×10^{-6} 3.6×10^{-6}	2.68	15.5	231
16	947 1,393	3.0×10^{-5} 2.1×10^{-5}	1.88	11.3	238
17	931	4.7×10^{-5}	1.88	12.9	239
18	943 1,350	3.0×10^{-5} 1.7×10^{-5}	1.70	13.3	241
19	1,118	1.9×10^{-6}	3.18	28.6	349
20	1,118	2.3×10^{-6}	4.08	20.1	9
21	1,050	3.0×10^{-6}	3.41	20.9	15
22	1,072	2.5×10^{-6}	3.46	22.1	5

\+ Maximum values of χ/Q are estimated by drawing a curve through the data points.

++ Measure at 10 meter-tower near Pit No. 5.

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The general trend of the observed maximum concentration is seen to be similar to the behavior theoretical predictions. There is an obvious decrease in the measured concentration with an increasing value of the standard deviation of the horizontal wind direction. While the maximum concentrations for the SF_6 tracer seem to follow in accordance with the atmospheric stability classification, one would infer from the σ_Θ values, this may be more coincidental than actual or, at best, would apply only to the southwesterly winds. What is pertinent is the observation that the maximum concentrations do appear to be a continuous function of σ_Θ, and that the theory predicts concentrations characteristic of a neutrally stable atmosphere when both the vertical temperature profile and σ_Θ data would result in this stability classification.

Rather than associate an hourly-average value of σ_Θ to a horizontal atmospheric stability scheme, it is assumed that the site-specific dispersion parameters are functions of σ_Θ in a neutrally stable atmosphere. One can then use the maximum concentrations from the tracer experiments to calculate values of the dispersion parameters instead of assuming a relationship between atmospheric stability and the hourly-average value of σ_Θ. In the case of the maximum concentrations, this is relatively straightforward because the model reduces to the simple form:

$$\frac{\overline{u}\overline{\chi}}{Q} \quad \frac{0.3939}{\sigma_z \Theta_m R}$$

at the distance of the fixed receptors from the point source.

3.1 Site-Specific Vertical Dispersion Parameters

The values of σ_z determined from the above equation, where $\overline{u\chi}/Q$ is taken to be maximum concentration given in Table 1, are shown in Figures 2 and 3 for the inner and outer array of receptors, respectively. The values of σ_z for the inner ring of receptors was fit to the linear regression equation

$$\sigma_z(\sigma_\Theta) = 9.184\ \sigma_\Theta - 87.33 \text{ (meters)}$$

with a correlation coefficient, r , of 0.9531. The values of the Pasquill-Gifford dispersion parameters for a D-, C- and B-stability classification are indicated on the left-hand side of this figure, and the equivalent horizontal stability classification associated with the measured values of σ_Θ are shown at the top of the figure.

The values of σ_z determined from the maximum concentration data at the outer ring of receptors was fit by the linear regression equation

$$\sigma_z(\sigma_\Theta) = 11.285\,\sigma_\Theta - 105.26$$

with a correlation coefficient of 0.9393. The regression equation for the inner ring is also shown in Figure 3. A third curve is also presented which assumes that the vertical dispersion parameter grows as Pasquill-Gifford dispersion parameters for a D-stability classification between the inner and outer ring of receptors

$$\sigma_z(R,\sigma_\Theta) = [9.184\,\sigma_\Theta - 87.33]\left(\frac{R}{940}\right)^{0.75}$$

within the range of these data. The difference between the linear regression equation and this predictive equation is not significant. Consequently, it is sufficient to assume that the growth of the vertical dispersion parameter with downwind distance approximates the growth of a neutrally stable atmosphere.

The data for Test Nos. 19, 20, 21, and 22 were analyzed in the same manner, but there were only sufficient data for the calculation of the σ_z at the outer ring of receptors ($R \simeq 1100$ meters). These tests differ from those described above in that the winds were from the north-northwest and north rather than the southwest. Table 2 summarizes the calculated values of σ_z for these tracer experiments. Unlike the previous tracer test data, the maximum concentrations appear to be represented by a vertical dispersion parameter which is independent of the value of σ_Θ. The value of $\sigma_z(\sigma_\Theta)$ from the correlations developed from the first series of tests are also presented in Table 2 for reference. While σ_Θ values measured at the 10-meter tower would result in an A-stability classification for Test No. 19 and a B-stability classification for Test Nos. 20, 21, and 22, the calculated values of σ_z are more representative of a C-stability at this downwind distance. Thus, the application of the model to these tracer data lead to more compact plumes than were experienced in the tests with southwesterly winds. This suggests a directional dependency in the dispersive characteristics of the atmosphere. Also, it is sufficient to characterize these limited data for northerly winds by a constant value of the vertical dispersion parameter of 63.5 meters at least for $\sigma_\Theta \geq 20$ degrees.

3.2 Comparison of Bivariate, Gaussian Plume Models

The meteorological and maximum concentration data from these tracer tests can be modeled in various ways based on a bivariate, Gaussian plume model and the Pasquill-Gifford dispersion parameters. For example, one may employ a split-sigma model (S/P-G model), which uses the vertical temperature profile to determine the vertical stability classification, and the standard deviation of the horizontal wind direction to determine the horizontal stability classification. The corresponding vertical (σ_z) and horizontal (σ_y) dispersion parameters would then be selected from the Pasquill-Gifford curves for the downwind distance. Alternatively, one may disregard the vertical temperature profile-determined stability classification and use the σ_Θ data to assign an atmospheric stability classification to employ in conjunction with the Pasquill-Gifford dispersion parameters (V/P-G model).

Table 3 presents a comparison of the maximum concentrations observed in the tracer tests with the predicts from the NUS model and the two bivariate, Gaussian plume models. In the case of the NUS model, the ratio of the

TABLE 2

VERTICAL DISPERSION PARAMETERS FOR
TRACER TEST NOS. 19, 20, 21 AND 22

Test No.	σ_Θ (deg.)	R (meter)	σ_z (meter)	σ_z* (meter)
19	28.6	1118	68.3	204.0
20	20.1	1118	62.6	116.2
21	20.9	1050	58.8	124.4
22	22.1	1072	64.4	136.8

* Calculated value of σ_z based on the results of Test Nos. 7, 8, 9, 10, 11, 16, 17 and 18.

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TABLE 3

COMPARISON OF BIVARIATE GAUSSIAN PLUME MODEL PREDICTIONS OF MAXIMUM CONCENTRATIONS WITH OBSERVED MAXIMUM CONCENTRATIONS

Test No	R (meter)	$\overline{u}\chi/Q$ (Meter)^2			
			Gaussian Plume Models		
		Observed	NUS Model	S/P-G	V/P-G
7	945	4.45×10^{-5}	5.98×10^{-5}	1.63×10^{-4}	1.63×10^{-4}
	1,370	2.22×10^{-5}	3.91×10^{-5}	8.77×10^{-5}	8.77×10^{-5}
8	910	9.38×10^{-6}	8.56×10^{-6}	7.78×10^{-5}	2.30×10^{-5}
	1,363	5.36×10^{-6}	4.22×10^{-6}	4.19×10^{-5}	1.06×10^{-5}
9	922	6.55×10^{-6}	6.92×10^{-6}	7.78×10^{-5}	2.30×10^{-5}
	1,363	4.10×10^{-6}	3.49×10^{-6}	4.19×10^{-5}	1.06×10^{-5}
10	916	8.86×10^{-6}	1.08×10^{-5}	7.58×10^{-5}	2.32×10^{-5}
	1,321	4.99×10^{-6}	3.40×10^{-6}	$4,19 \times 10^{-5}$	1.07×10^{-5}
11	950	1.77×10^{-5}	1.63×10^{-5}	1.05×10^{-4}	3.09×10^{-5}
	1,362	9.65×10^{-6}	8.60×10^{-6}	6.07×10^{-5}	2.85×10^{-5}
16	947	5.64×10^{-5}	7.50×10^{-5}	1.58×10^{-4}	1.58×10^{-4}
	1,363	3.95×10^{-5}	3.79×10^{-5}	8.64×10^{-5}	8.64×10^{-5}
17	931	4.70×10^{-5}	3.55×10^{-5}	1.06×10^{-4}	5.78×10^{-5}
18	943	5.10×10^{-5}	3.02×10^{-5}	1.08×10^{-4}	5.90×10^{-5}
	1,350	2.89×10^{-5}	1.61×10^{-5}	5.91×10^{-5}	2.81×10^{-5}
19	1,118	6.04×10^{-6}	6.50×10^{-6}	3.49×10^{-5}	2.29×10^{-6}
20	1,118	9.38×10^{-6}	9.25×10^{-6}	4.87×10^{-5}	1.50×10^{-5}
21	1,050	1.02×10^{-5}	9.47×10^{-6}	5.58×10^{-5}	1.70×10^{-5}
22	1.072	8.65×10^{-6}	8.77×10^{-6}	5.18×10^{-5}	1.64×10^{-5}

predicted-to-observed maximum concentrations varied from 0.56 (Test No. 18) to 1.76 (Test No.7) with an average ratio of 0.98. The split-sigma (S/P-G) model was the poorest, giving a ratio of predicted-to-observed maximum concentration from 2.12 (Test No. 18) to 11.89 (Test No. 9). The average ratio of predicted-to-observed maximum concentration for this model is 5.73. When the atmospheric stability was determined from the standard deviation of the horizontal wind direction, then the ratio of predicted-to-observed maximum concentration ranged from 0.38 (Test No. 19) to 3.95 (Test No. 7). The average value of this ratio is 2.18 for the V/P-G model.

The application of a bivariate, Gaussian plume model to these tracer test data requires the vertical and horizontal dispersion to be enhanced. The NUS model accomplishes this by the treatment of plume meander and an empirical fit to the field data. In the case of V/P-G model, the same end is achieved by the assumption that one can classify the stability of the atmosphere from the horizontal wind variance. This empirical approach fails when it leads to a neutrally stable (Test Nos. 7 and 16) or a very unstable (Test No. 19) atmosphere. One can further improve the predictive capability of the V/P-G model by the additional empirical constraint that the dispersive properties of the atmosphere be classed only as moderately unstable (C-stability) or unstable (B-stability) when the general classification of the atmospheric stability, either from a vertical temperature profile or the Pasquill-Turner scheme, is neutral. This additional empirical constraint leads to a ratio of predicted-to-observed maximum concentration from 0.70 (Test No. 16) to 3.51 (Test No. 9), and an average value of 1.85 for this ratio.

Some degree of conservativism can be incorporated in the NUS and V/P-G models by the introduction of a scale factor such that the ratio of predicted-to-observed maximum concentrations is always greater or equal to unity. This ensures that the model will always predict a concentration greater than or equal to any maximum concentration observed in a tracer test. The scale factor for the NUS model would be 1.78 (=1/0.56), which, if applied, would give a maximum and average value of 3.13 and 1.74, respectively, for the ratio. The V/P-G model would require a scale factor of 1.43 (=1/0.7) so that the maximum value of the ratio becomes 4.98. The average value of the ratio would increase to 2.63 for the V/P-G model. On this basis, the V/P-G model would compound the conservativism in the scaled NUS model by a multiplicative factor of 1.5(=2.63/1.74). Without further evidence to the contrary, the NUS model would be recommended with a scale factor of 1.78, since it provides a conservative, but not overly conservative, prediction of the maximum concentration.

4.0 EVACUATION SECTOR SIZE

The effect of plume meander is to decrease the expected maximum concentrations from the centerline values within the plume, but it also broadens the crosswind area with concentrations near the maximum. It is possible to determine the angular sector about the mean wind direction within which the expected concentrations will be below some level. For q $\geq$2.0, the angular sector,

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$\mu = \pm\ \beta\ \Theta_m$, within which the expected concentration exceeds the value $\overline{\chi}(R)/\overline{\chi}_0(R)$ can be estimated from the equation:

$$\mu = |\Theta_m| + \sin^{-1}\left[\frac{1}{q}\sin(|\Theta_m|)\ C\left(\frac{\overline{\chi}}{\overline{\chi}_0}\right)\right]$$

Where $C=C(\overline{\chi}/\overline{\chi}_0)$ is a function that depends on the desired concentration reduction. The following table gives the values of $C(\chi/\chi_0)$ as a function of $\overline{\chi}(R)/\overline{\chi}_0(R)$.

$\frac{\overline{\chi}}{\overline{\chi}_0}$	$C\left(\frac{\overline{\chi}}{\overline{\chi}_0}\right)$
0.5	0.000
0.4	0.180
0.3	0.371
0.2	0.596
0.1	0.907
0.05	1.163

The procedure to determine the evacuation sector is illustrated for the case of $q = 2.5$, $\sigma_\Theta = 15^o$, and $\overline{\chi}/\overline{\chi}_0 = 0.1$. From the above table, $C = 0.907$ and $\sin(\Theta_m) = \sin(3\sigma_\Theta) = 0.438$, recalling that $\Theta_m = 3\sigma_\Theta$. Thus, the evacuation sector is:

$$\mu = \sqrt{3}(15) + \sin^{-1}\left[\frac{(0.438)(0.907)}{(2.0)}\right] = 37.4^o$$

The evacuation sector would be the sector defined by $\pm 37.4^o$ on either side of the mean wind direction. This angle corresponds to approximately $3.56\sigma_y$.

From the definition of q, the evacuation sector equation can be rewritten:

$$\mu = \sqrt{3}^1\sigma_\Theta + \sin^{-1}\left[\frac{\sqrt{2}\sigma_y}{R}\ C\left(\frac{\overline{\chi}}{\overline{\chi}_0}\right)\right]$$

While the values of σ_y must be determined from the cross-wind distribution data observed in the tracer tests, it would be conservative to take the Pasquill-Gifford dispersion parameters for a B-stability. For example, if $R = 1000$ meters, $\sigma_\Theta = 15^o$ and $\chi/\overline{\chi}_0 = 0.1$, then

$$\mu = \sqrt{3}(15) + \sin^{-1}\left[\frac{\sqrt{2}(158)}{(1000)}\ (0.907)\right] = 37.7^o$$

while for R = 2000 meters

$$\mu = \sqrt{3}(15) + \sin^{-1}\left[\frac{\sqrt{2}(292)}{(2000)}\ (0.907)\right] = 36.8^o$$

References

1. R. W. Jubach, "Lackawanna Superfund Site Atmospheric Study," NUS-4472, February 1984.

2. NUS Corporation, "Application to Amend PSD Permit 78MD08-R for Sulfur Dioxide Emissions from Unit No. 5 at the Amcelle Plant in Cumberland, Maryland," NUS-4060, March 1982.

FIGURE 3 CALCULATED VERTICAL DISPERSION PARAMETERS BASED ON MAXIMUM CONCENTRATIONS AT THE OUTER RING OF RECEPTORS

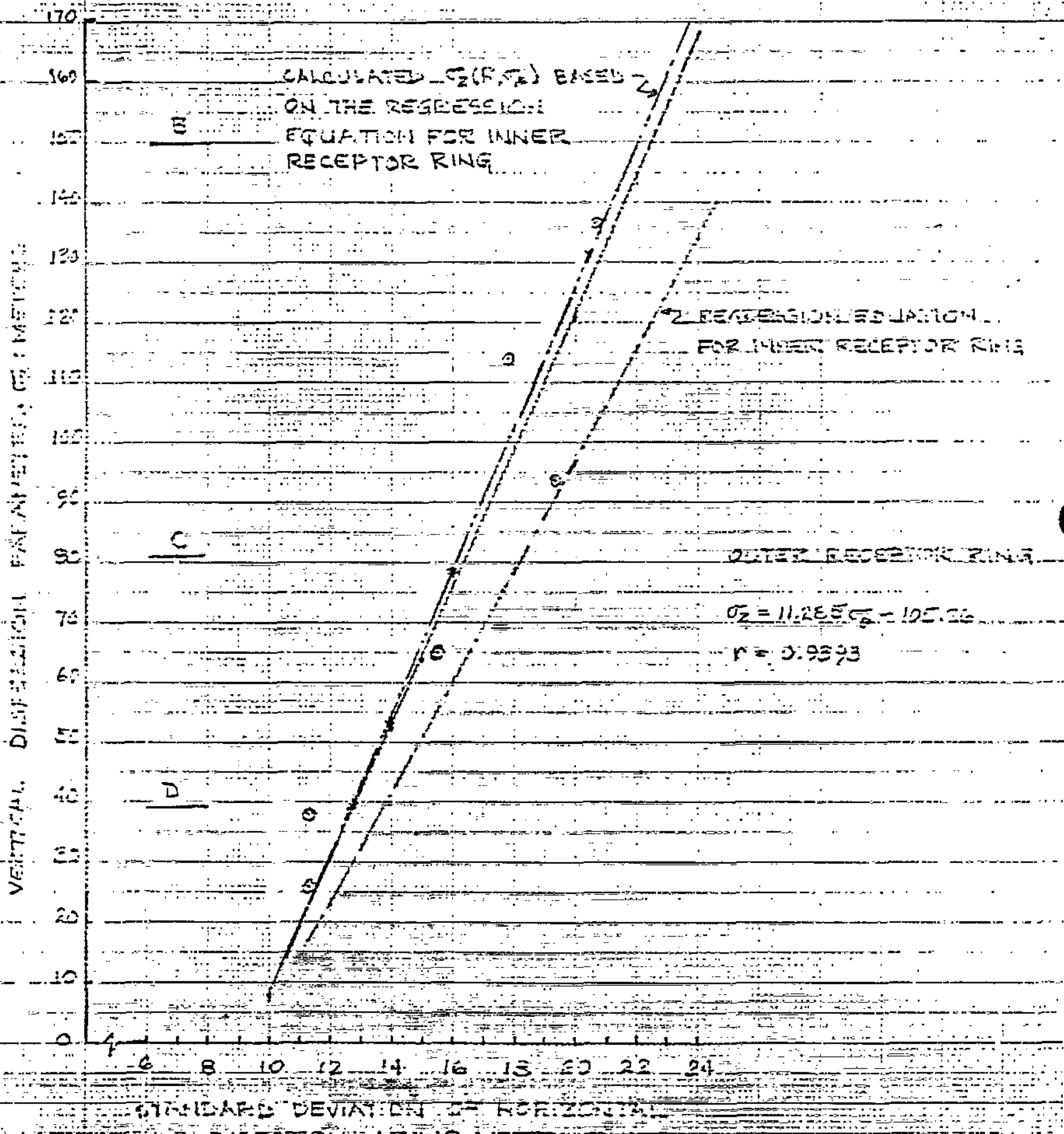

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FIGURE 2 CALCULATED VERTICAL DISPERSION PARAMETER BASED ON MAXIMUM CONCENTRATIONS AT THE INNER RING OF RECEPTORS

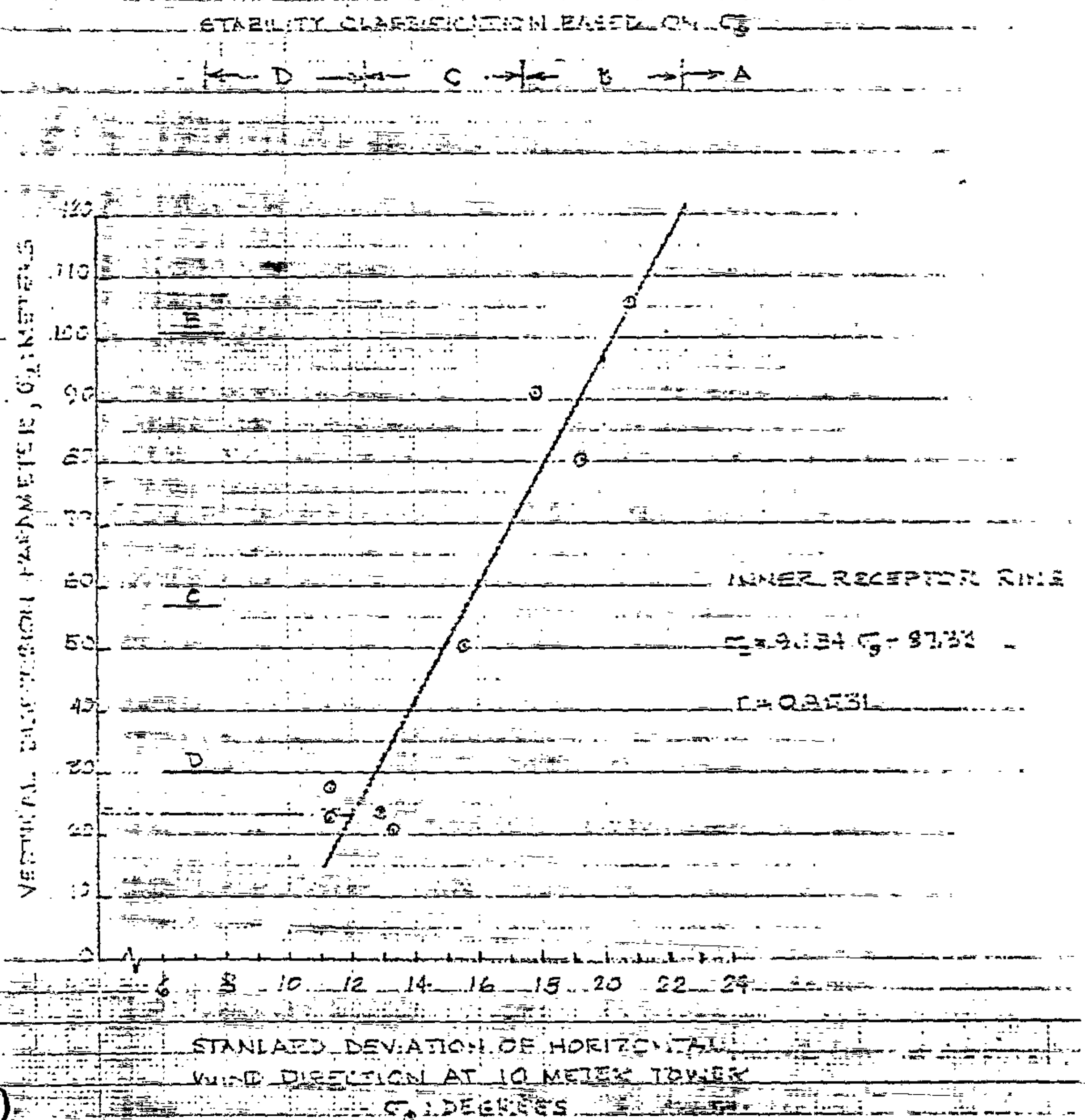
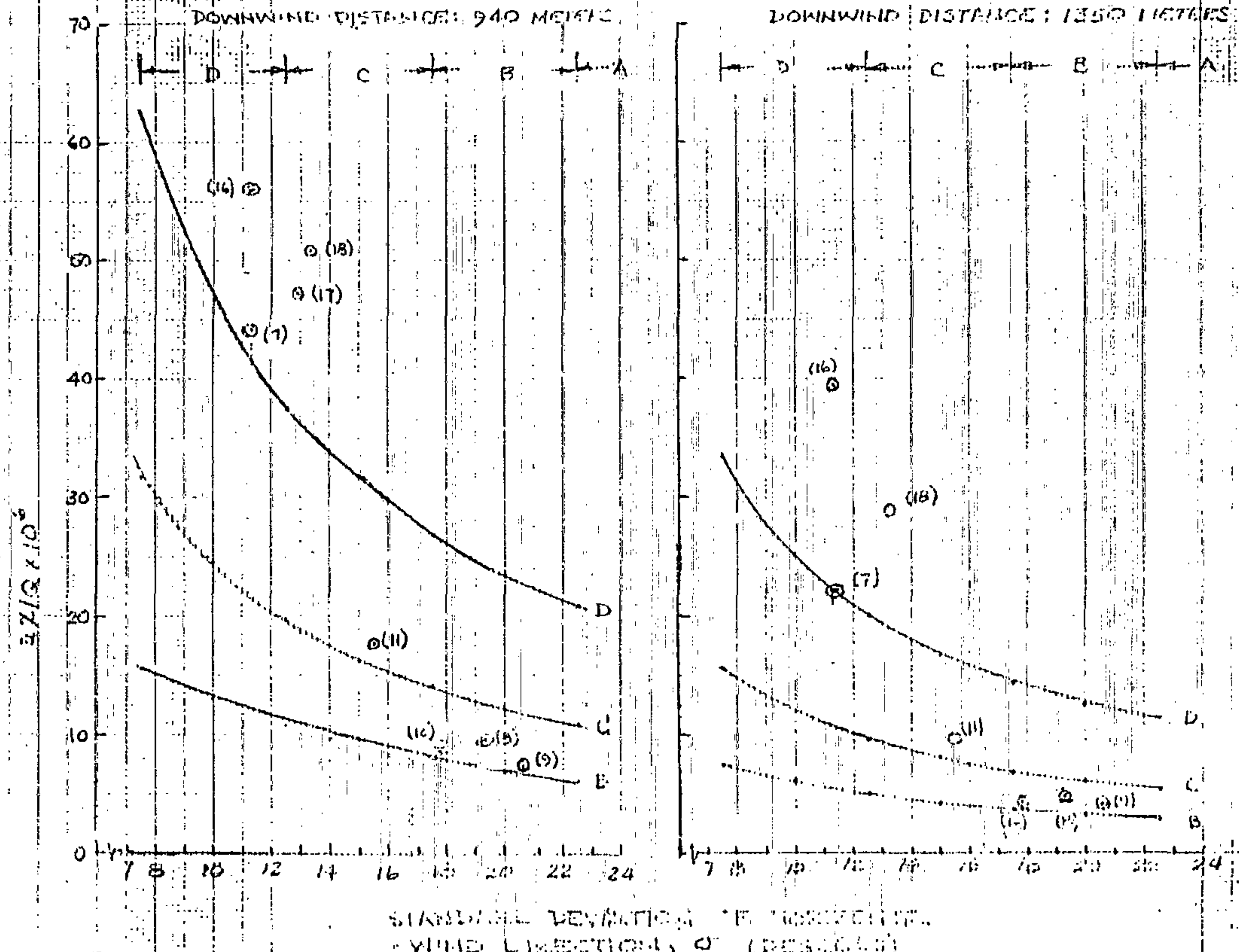


FIGURE 4: COMPARISON OF PREDICTED AND OBSERVED MAXIMUM CONCENTRATIONS FROM SF_6 TRACER TESTS



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region III - 6th & Walnut Sts.
Philadelphia, Pa. 19106

ORIGINAL
(red)

SUBJECT: Preliminary Assessment of the Lackawanna Refuse Site, Lackawanna, PA

DATE: OCT 12 1984

FROM: Bruce Potoka, On-Scene Coordinator BP
Site Response Section (3HW21)

TO: Abraham Ferdas, Chief
Site Response Section (3HW21)

In accordance with the National Contingency Plan, a preliminary assessment was conducted at the Lackawanna Refuse Site in Lackawanna, PA. Based on a thorough review of currently available information, it is the OSC's determination that an immediate removal action is not necessary at this time.

Sampling data from the site was compiled and forwarded to the Superfund Implementation Group, Centers for Disease Control for their assessment. Of particular concern was the need to fence off seepage areas that lie to the exterior side of currently existing fences.

The reviewers (CDC-SIC) concluded that no apparent need exists to provide additional fencing around the seeps. The SIC group did recommend that frequent monitoring of the site should be maintained to quickly detect any changes. (Attached)

The OSC concurs with the CDC position and recommends that seeps be monitored during the ongoing site investigations.

Attachment

DEPARTMENT OF HEALTH & HUMAN SERVICES

ORIGINAL
Public Health Service
Centers for Disease Control
(red)

Memorandum

Date September 26, 1984

From Chief, Superfund Implementation Group, CEH

Subject Lackawanna Refuse Site
Lackawanna, Pennsylvania

To Charles J. Walters
Public Health Advisor
EPA Region III

The sampling data from the above site which was provided by Mr. Bruce Potoka of the EPA Regional office has been reviewed within the Superfund Implementation Group, Centers for Disease Control. I hope the comments are useful:

1) The reviewers feel there is no apparent need to provide additional fencing around the seeps at the site. While there are substances present which should be considered for cleanup when possible, the remote nature of the seeps does not appear to present an immediate and significant threat to the residents in the area.

2) Frequent monitoring of the site should be maintained to detect any changes which might have impact upon the public. Such monitoring should include, in addition to sampling, a check of the signs and gates to warn those who enter that hazardous material is present.

We will be happy to review additional information on the site should you require it.

for Georgi A. Jones

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